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Development of a Fizeau Phase Diverse Testbed

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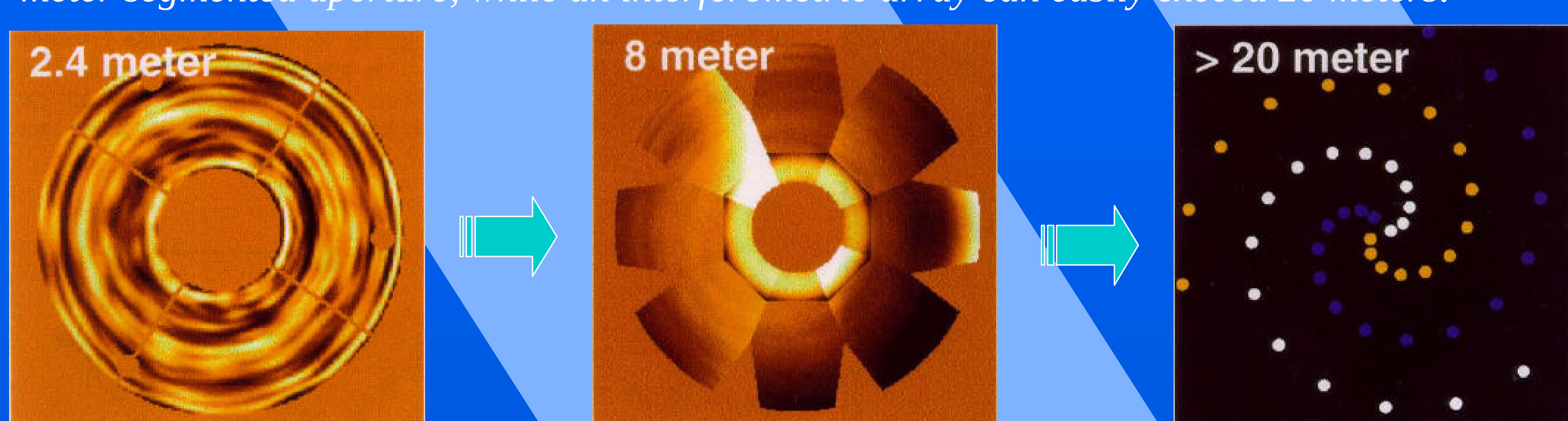
Why an Interferometer?

Problem: Earth and space missions have an increasing need for greater spatial resolution while still being constrained by the same parameters of size, weight, and expense as previous missions have been.

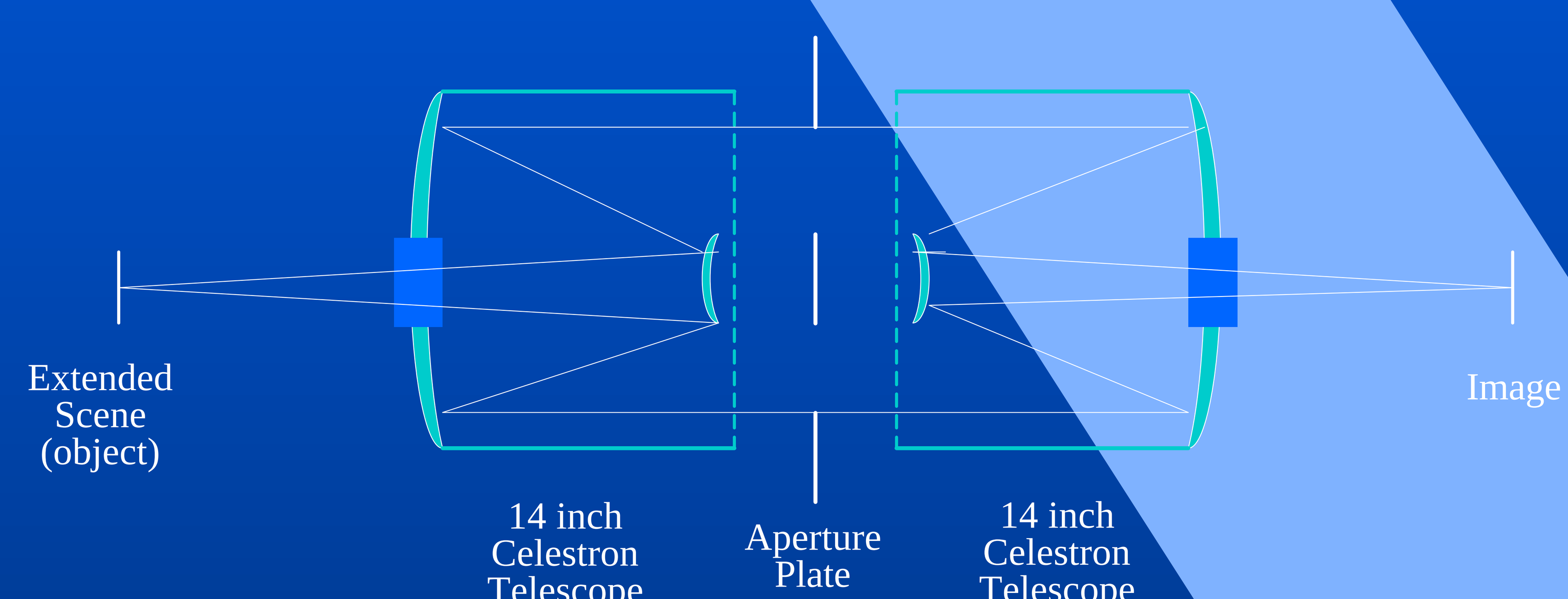
Solution: Develop formation flying of sparse or interferometric arrays, which serve to maximize spatial response while minimizing the aperture area.

The primary mirror on the Hubble Space Telescope is 2.4 meters and NGST is likely to be an 8 meter segmented aperture, while an interferometric array can easily exceed 20 meters.

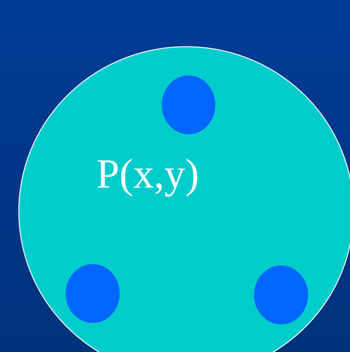


Problem: While ground-based interferometers have proven successful, applications in space add the extra complication of varying baselines and surface aberrations due to thermal and gravitational effects.

Solution: Wavefront sensing techniques replace hardware as a means to simultaneously determine surface geometry and resulting image in order to understand the source.



FPDT Experiment Setup



Basic schematic of the moving aperture plate to model 3 spacecraft flying in formation

Current Work

The computer controlled imaging system is coordinated through a real-time interface being developed in **LabWindows / CVI** (a C-based engineering program) in order to:

•Perform motion following formation flying trajectories with conservation of moment of inertia

•Control position of adjustable telescopes and traveling CCD camera to maintain alignment

•Interface with Beowulf cluster for processing of data through algorithms.

Future Work

•Execute variety of different simulations to show robustness of algorithm

•Evaluate different control laws

•Design optimal control algorithm for rotating apertures

What is the FPDT?

Purpose

The Fizeau Phase Diverse Testbed (FPDT) is being developed to explore algorithms for synthetic aperture imaging and the use of wavefront sensing to control aperture locations and misalignments.

Goals

- Provide NASA/GSFC with potential high resolution imaging method
- Proof of principle and experience with data
- Characterize and quantify with computational models and actual lab data
- Compare and contrast with more conventional methods
- Determine accuracy, precision, dynamic range, robustness, and sensitivity of phase retrieval techniques.

Applications

Phase retrieval techniques were originally developed and used for recovering early **HST** images, where pre and post-Costar images proved useful in testing wavefront sensing methods. These techniques are being researched and improved upon for use in future systems such as the Sub-millimeter Probe of Cosmic Evolution (**SPECS**), Stellar Imager (**SI**) and the Terrestrial Planet Finder (**TPF**), which will probably show the first examples of formation flying of interferometric arrays.

FPDT Process

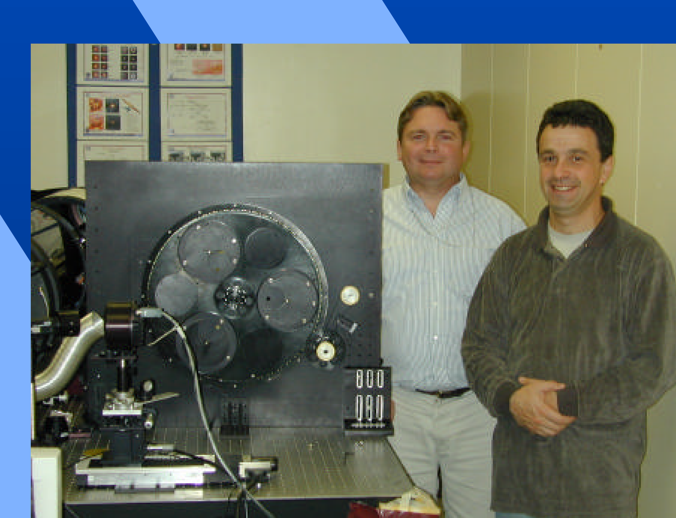
Rotate apertures to model formation flying interferometric array

Introduce diversity into optical assembly

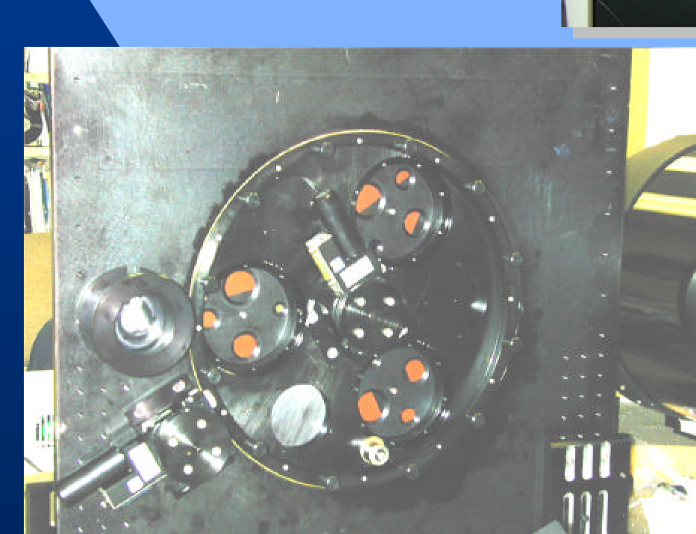
Interfere beams and generate wavefront shape and image

Use shape of wavefront to determine aberrations of the optical system

Iteratively process wavefront and image to determine the high resolution object

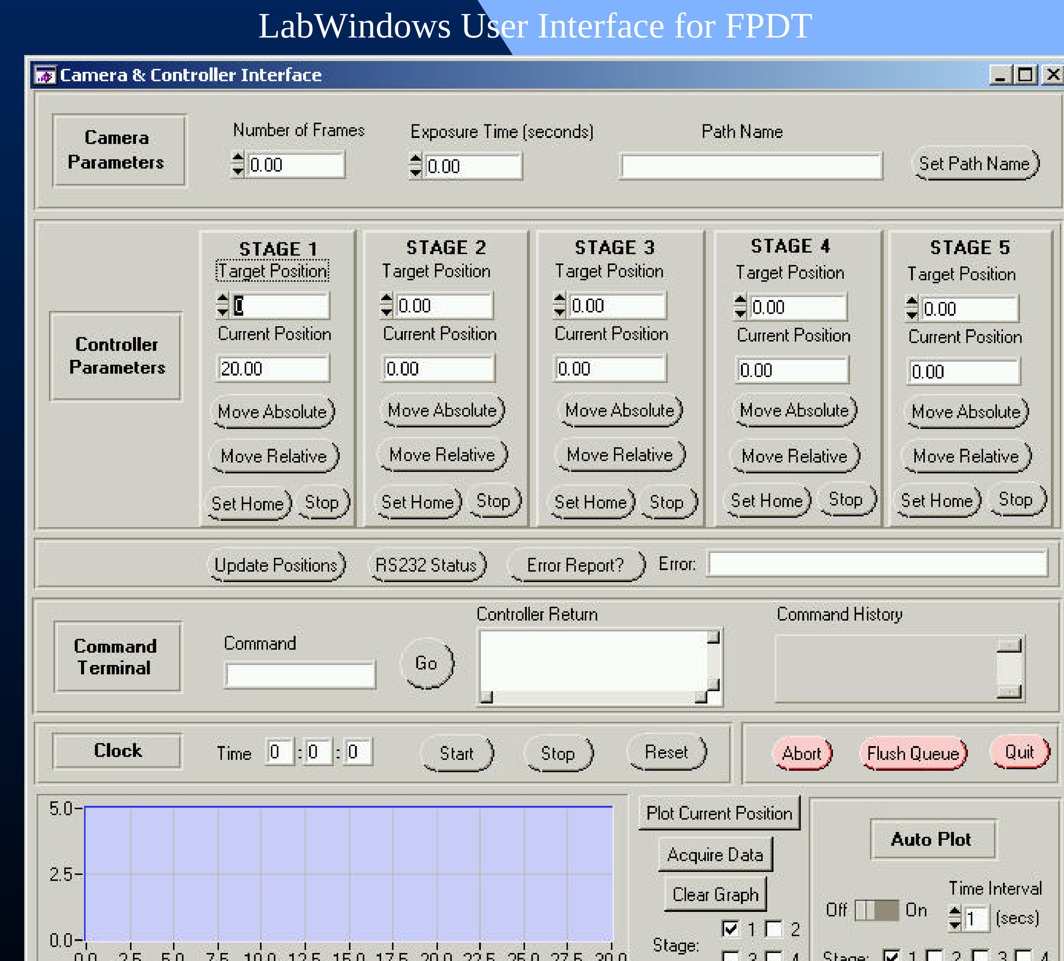


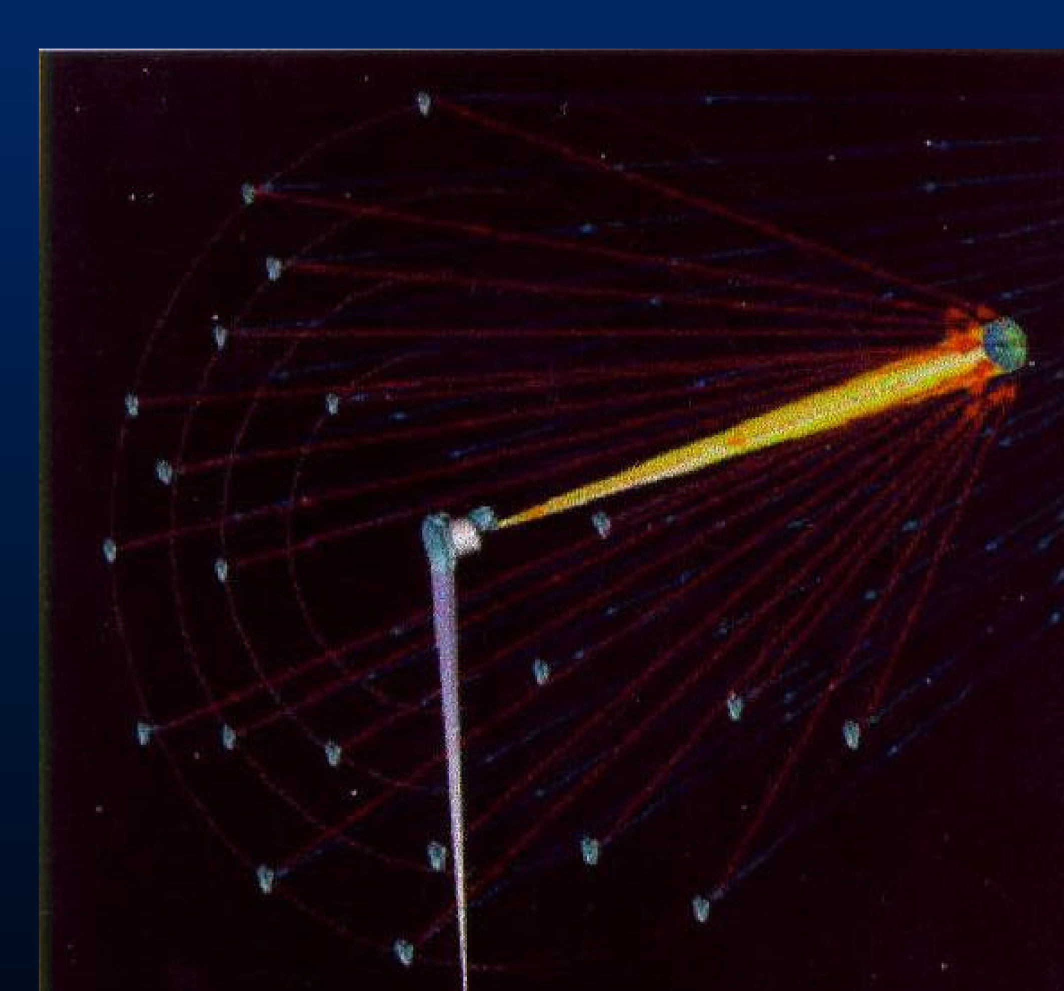
Front side of moving aperture plate, with PI Rick Lyon and CoI Greg Solyar



Back of moving aperture plate

LabWindows User Interface for FPDT





Rendering of the concept of formation flying, where individual spacecraft are distributed over a wide area. They optically collect light and then relay it to a central hub, where the beam are interfered and then processed to create an image.